AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions and listings of claims in the application:

1. (Currently Amended) A locator receiver, comprising:

at least one processing channel including an electromagnetic field detector, an analog processor coupled to receive signals from the electromagnetic field detector, and a digital processor coupled to receive signals from the analog processor and calculate a signal strength parameter and a modulated signal, wherein the modulated signal is configured to provide data concerning a direction of a signal to distinguish a target conductor,

wherein the digital processor includes an analog-to-digital converter, a digital phase-locked loop coupled to receive the output signal from the analog-to-digital converter and provide the signal strength parameter, and a nested digital phase-locked loop coupled to the phase-locked loop to provide the modulated signal.

2. (Currently Amended) ~~The locator of claim 1,~~A locator receiver, comprising:

at least one processing channel including an electromagnetic field detector, an analog processor coupled to receive signals from the electromagnetic field detector, and a digital processor coupled to receive signals from the analog processor and calculate a signal strength parameter and a modulated signal,

wherein the digital processor includes an analog-to-digital converter, a digital phase-locked loop coupled to receive the output signal from the analog-to-digital converter and provide the signal strength parameter, and a nested digital phase-locked loop coupled to the phase-locked loop to provide the modulated signal,

wherein the analog-to-digital converter operates at twice the bandwidth of a highest selectable frequency of an electromagnetic field detected by the electromagnetic field detector.

3. (Currently Amended) ~~The locator of claim 1,~~ A locator receiver, comprising:

at least one processing channel including an electromagnetic field detector, an analog processor coupled to receive signals from the electromagnetic field detector, and a digital processor coupled to receive signals from the analog processor and calculate a signal strength parameter and a modulated signal; and

a processor coupled to receive the signal strength parameter from each of the at least one processing channel and provide values of characteristics of a conductor based on the signal strength parameter to a display,

wherein the digital processor includes an analog-to-digital converter, a digital phase-locked loop coupled to receive the output signal from the analog-to-digital converter and provide the signal strength parameter, and a nested digital phase-locked loop coupled to the phase-locked loop to provide the modulated signal.

4. (Original) The locator of claim 3, wherein values include an electric current in the conductor.

5. (Original) The locator of claim 3, wherein values include a depth of the conductor below a surface.

6. (Original) The locator of claim 3, wherein values include a location of the conductor.

7. (Currently Amended) ~~The locator of claim 1,~~ A locator receiver, comprising:

at least one processing channel including an electromagnetic field detector, an analog processor coupled to receive signals from the electromagnetic field detector, and a digital processor coupled to receive signals from the analog processor and calculate a signal strength parameter and a modulated signal,

wherein the digital processor includes an analog-to-digital converter, a digital phase-locked loop coupled to receive the output signal from the analog-to-digital converter and provide the signal strength parameter, and a nested digital phase-locked loop coupled to the phase-locked loop to provide the modulated signal,

wherein the analog-to-digital converter operates at a sample rate of less than twice the bandwidth of a highest selectable locate frequency.

8. (Original) The locator of claim 1, wherein the analog processor further includes a programmable gain amplifier.

9. (Original) The locator of claim 1, further including a signal direction detector to determine a signal direction.

10. (Original) The locator of claim 1, wherein the modulated signal provides communications with a buried object that generates an electromagnetic field detected by the electromagnetic field detector.

11. (Original) The locator of claim 10, wherein the buried object is a sonde.

12. (Original) The locator of claim 10, wherein the buried object is a marker.

13. (Original) The locator of claim 1, wherein the electromagnetic field detector detects electromagnetic fields generated by an elongated conductor coupled to a transmitter.

14. (Currently Amended) ~~The locator of claim 1,~~ A locator receiver, comprising:

at least one processing channel including an electromagnetic field detector, an analog processor coupled to receive signals from the electromagnetic field detector, and a digital processor coupled to receive signals from the analog processor and calculate a signal strength parameter and a modulated signal,

wherein the digital processor includes an analog-to-digital converter, a digital phase-locked loop coupled to receive the output signal from the analog-to-digital converter and provide the signal strength parameter, and a nested digital phase-locked loop coupled to the phase-locked loop to provide the modulated signal,

wherein the digital phase-locked loop comprises:

a numerically controlled oscillator coupled to receive an error signal and update a carrier frequency, a cosine signal, and an inverted sine signal;

a quadrature arm coupled to receive the inverted sine signal and the output signal from the analog-to-digital converter and generate a quadrature signal;

an in-phase arm coupled to receive the cosine signal and the output signal from the analog-to-digital converter and generate an in-phase signal; and

an error block coupled to receive the quadrature signal and the in-phase signal and calculate the error signal.

15. (Original) The locator of claim 14, wherein the in-phase signal is related to the signal strength parameter.

16. (Original) The locator of claim 14, wherein the error block executes a transfer function to perform a fixed-point inverse tangent approximation.

17. (Original) The locator of claim 14, wherein the quadrature arm includes

a multiplier coupled to receive the inverted sine signal and the output signal from the analog-to-digital converter, the multiplier providing a mixed output signal;

a low-pass filter coupled to filter the mixed output signal and produce a filtered signal; and

an amplifier coupled to amplify the filtered signal.

18. (Original) The locator of claim 14, wherein the in-phase arm includes

a multiplier coupled to receive the cosine signal and the output signal from the analog-to-digital converter, the multiplier providing a mixed output signal;

a low-pass filter coupled to filter the mixed output signal and produce a filtered signal; and

an amplifier coupled to amplify the filtered signal.

19. (Original) The locator of claim 14, wherein the numerically controlled oscillator calculates the carrier frequency according to the equation $f(n+1)=f(n)+\beta e(n)$, a phase according to the equation $\theta(n+1)=\theta(n)+\alpha e(n)+f(n)$, and the sine and cosine values from the phase.

20. (Original) The locator of claim 19, wherein $\beta=\alpha^2/4$.

21. (Original) The locator of claim 14, wherein the nested digital phase-locked loop is coupled to receive the inverted sine signal from the numerically controlled oscillator and an unfiltered mixed output signal from a multiplier of the quadrature arm, and wherein the modulated signal is a nested phase signal.

22. (Original) The locator of claim 21, wherein the nested digital phase-locked loop includes a FM numerically controlled oscillator coupled to receive an error signal, and the carrier frequency, and provides an inverted sine signal and a cosine signal, the numerically controlled oscillator also generating the modulated signal.

23. (Original) The locator of claim 22, wherein the error signal is generated in an error block that receives signals from a quadrature arm and an in-phase arm coupled to the FM numerically controlled oscillator.

24. (Original) The locator of claim 22, further including a comparator that receives the modulated signal and keeps the modulated signal at modulo 2π.

25. (Original) The locator of claim 24, further including a zero-crossing detector coupled to the comparator to determine when the modulated signal crosses zero to produce a carrier index.

26. (Original) The locator of claim 21, further including a filtering and downsampling block coupled to receive the unfiltered mixed output signal from the multiplier of the quadrature arm and produce a signal to the nested phase-locked loop.

27. (Original) The locator of claim 25, wherein the carrier index is utilized to sample the carrier signal from the numerically controlled oscillator to produce a sampled signal.

28. (Original) The locator of claim 27, wherein a signal direction signal is determined from the sign of the sampled signal.

29. (Currently Amended) A method of signal processing, comprising:

receiving a signal in a detector;

digitizing the signal to form a digitized signal;

determining a signal strength from an output signal of a digital phased-lock loop coupled to receive the digitized signal; and

determining a modulated signal in a nested digital phased-lock loop coupled to the digital phased-lock loop, wherein the modulated signal is configured to provide data concerning a direction of a signal to distinguish a target conductor.

30. (Currently Amended) ~~The method of claim 29,~~ A method of signal processing, comprising:

receiving a signal in a detector;

digitizing the signal to form a digitized signal;

determining a signal strength from an output signal of a digital phased-lock loop coupled to receive the digitized signal; wherein determining the signal strength from the output signal of the digital phase-lock loop comprises:

updating an inverted sine value and a cosine value based on an error signal~~;~~,

mixing the inverted sine value with the signal in a quadrature arm to form a quadrature signal~~;~~,

mixing the cosine value with the signal in an in-phase arm to form an in-phase signal~~;~~, and

determining the error signal from the quadrature signal and the in-phase signal; and

determining a modulated signal in a nested digital phased-lock loop coupled to the digital phased-lock loop.

31. (Original) The method of claim 30, wherein the signal strength is determined from the in-phase signal.

32. (Original) The method of claim 30, wherein the quadrature arm includes filtering and amplifying to form the quadrature signal.

33. (Original) The method of claim 30, wherein the in-phase arm includes filtering and amplifying to form the in-phase signal.

34. (Original) The method of claim 30, further including updating a carrier frequency with the sine value and the cosine value.

35. (Original) The method of claim 34, wherein determining a modulated signal in a nested digital phase-lock loop coupled to the digital phase-lock loop includes

updating a FM sine value, a FM cosine value, and a carrier index value based on an FM error signal and the carrier frequency,

calculating an FM quadrature signal by mixing the FM sine value with a signal received from a multiplier in the quadrature arm of the digital phase-locked loop;

calculating an FM in-phase signal by mixing the FM cosine value with the signal; and

calculating the error signal from the FM quadrature signal and the FM in-phase signal.

36. (Original) The method of claim 35, wherein the modulated signal is a demodulated FM phase signal and further including determining a signal direction from the demodulated FM phase signal.

37. (Currently Amended) A line locator, comprising:

means for determining a signal strength; ~~and~~

means for determining a signal direction in a conductor; and

means for distinguishing a target conductor based on the determined signal strength and signal direction.

38. (Currently Amended) A locator receiver, comprising:

a first digital phase-locked loop with a first numerically controlled oscillator coupled to receive a signal and provide a first phase related to a first frequency; and

a second digital phase-locked loop with a second numerically controlled oscillator coupled to receive the signal and provide a second phase related to a second frequency,

wherein the signal related to the first frequency and the signal related to the second frequency determine a signal direction of a conductor.

39. (Original) The receiver of claim 38, wherein a signal direction is determined from a comparison of the first frequency multiplied by a first integer and the second frequency multiplied by a second integer.

40. (Original) The receiver of claim 38, wherein the first digital phase-locked loop updates the phase according to the loop equations $\theta(n+1)=\theta(n)+\alpha e(n)+f(n)$ and $f(n+1)=f(n)+\beta e(n)$.

41. (Original) The receiver of claim 40, wherein the parameter β is $\alpha^2/4$.

42. (Original) The receiver of claim 38, wherein the second digital phase-locked loop updates the phase according to the loop equations $\theta(n+1)=\theta(n)+\alpha e(n)+f(n)$ and $f(n+1)=f(n)+\beta e(n)$.

43. (Original) The receiver of claim 42, wherein the parameter β is $\alpha^2/4$.

44. (Original) A method of determining signal direction, comprising:

receiving a digitized signal;

determining a first phase with a first digital phase-locked loop locked to a first frequency;

determining a second phase with a second digital phase-locked loop locked to a second frequency;

determining the signal direction in a conductor from the first frequency and the second frequency.

45. (Original) The method of claim 44, wherein determining the first phase includes updating loop equations within a numerically controlled oscillator.

46. (Original) The method of claim 44, wherein determining the second phase includes updating loop equations within a numerically controlled oscillator.

47. (Currently Amended) A locator receiver, comprising:

a first digital phase-locked loop providing signals related to a first frequency of an input signal;

a second digital phase-locked loop providing signals related to a second frequency of the input signal,

wherein the signal related to the first frequency and the signal related to the second frequency determine a signal direction of a conductor.

48. (Original) The receiver of claim 47, wherein the first digital phase-locked loop is coupled to receive the input signal and the second digital phase-locked loop is coupled to receive the input signal.

49. (Original) The receiver of claim 47, wherein the first digital phase-locked loop is coupled to receive the input signal and the second digital phase-locked loop is coupled to receive a signal from the first digital phase-locked loop.